

PERFORMANCE CHEMICALS

TECHNICAL INFORMATION

PVP/VA

Vinylpyrrolidone/Vinyl Acetate
Copolymers

*Performance-Enhancing Products
for Consumer and Industrial Markets*

EX. A



INTERNATIONAL SPECIALTY PRODUCTS

FILM FORMERS FOR AEROSOL, AQUEOUS, AND ORGANIC SOLVENT SYSTEMS

International Specialty Products (ISP) offers formulators a series of vinylpyrrolidone/vinyl acetate copolymers. Members of the PVP/VA copolymer series serve as primary film formers in a variety of products demanding different degrees of water resistance. These copolymer films feature specific affinity for hair, skin and smooth surfaces such as wood, glass, paper, and metal, yet do not require solvents for removal.

The advantages of using PVP/VA copolymers as film formers are:

- film flexibility
- good adhesion
- luster
- water remoistenability
- hardness

These properties make PVP/VA copolymers suitable for a variety of industrial, personal care, and pharmaceutical products. The major industrial applications are in hot melt adhesives, photoresist binders and coatings for ink jet media paper, plastic film and other substrates.

The PVP/VA product line consists of thermoplastic copolymers with the following Tg properties as a function of vinylpyrrolidone (VP) content:

Wt% VP	Tg, °C
70	109
60	105
50	73
30	55

VP/VA COPOLYMER	PVP/VA E-735	PVP/VA E-635	PVP/VA E-535	PVP/VA E335	PVP/VA I-735	PVP/VA I-535	PVP/VA I-335	PVP/VA S-630	PVP/VA W-735	PVP/VA W635
Appearance (25°)	Clear liquid				Light yellow liquid			White powder	Viscous liquid	
Solvent	SDA-40 anhydrous ethanol				isopropanol			-----	water*	
Solids (Vacuum oven 130°C)	48-52%				48-52%			-----	48-52% (microwave oven)	
Vinylpyrrolidone/Vinyl Acetate										
Weight Ratio	70/30	60/40	50/50	30/70	70/30	50/50	30/70	60/40	70/30	60/40
K-Value* (1% w/v ethanol solution)	35-50	30-45	30-50	25-35	28-36	25-35	20-30	30-50		
Moisture (as is, Karl Fischer)	0.50% max.				0.5% max.			5% max. (Cenco)		
Residual Vinylpyrrolidone (as is)	100ppm max.				100ppm max.			100ppm max.	100ppm max.	
Residual Vinyl Acetate (as is)	100ppm max.				100ppm max.			100ppm max.	100ppm max.	
Nitrogen (based on solids)	8-9%	7-8%	5.8-6.8%	3.5-4.5%	8.0-9.0%	6.0-6.9%	3.9-4.9%	7.5-8.5%		

*K-value is a function of molecular weight

THE PVP/VA E AND I SERIES

To fit many application areas, the E and I series of PVP/VA copolymers are available as 50% solutions in ethanol and in isopropanol*, respectively. There are four distinct copolymers in the E group: E-335, E-535, E-635, E-735, and three in the I group: I-335, I-535, I-735. Each differs in monomer ratio and, therefore, in properties – water sensitivity, viscosity, softening point, etc. This affords formulators considerable flexibility in creating new products for specific applications. The transparent films formed by all of these copolymers are characterized by adhesion, luster, hardness and water rewettability. Good compatibility with many modifiers and plasticizers permits wide freedom in formulation and broadens the range of hygroscopicity, film flexibility, and abrasion resistance. Unmodified copolymers having the lower ratios of vinylpyrrolidone to vinyl acetate exhibit more moisture resistance than products with high ratios of VP.

THE PVP/VA S COPOLYMER

PVP/VA S-630 is a white, odorless powder, at 60/40 VP/VA weight ratio. It is a high molecular weight, solvent and water soluble copolymer exhibiting a minimal critical solution temperature of approximately 70°C. Films cast from solutions are glossy, translucent and rewettable by water.

THE PVP/VA W COPOLYMERS

PVP/VA W-735 is a 70/30 copolymer of PVP and vinyl acetate supplied as a 50% solution in water. PVP/VA W-635 is a 60/40 copolymer also supplied as a 50% aqueous solution. They are ideal nonionic fixative resins for alcohol-free mousses and gels. They offer formulators outstanding curl and style retention properties without build-up, flaking, or dulling of hair.

COMPATIBILITY

SOLVENTS: The PVP/VA E and I series of copolymers are soluble in a number of polar and nonpolar solvents, as illustrated below:

Solubility in Organic Solvents

		PVP/VA E- or I- Series (10% solids content**)
Alcohols	Methanol	S
	Ethanol	S
	Isopropanol	S
	Sec. Butanol	S
	Benzyl alcohol	S
	1,4 Butanediol	S
	Propylene glycol	S
	Glycerine	-
Ether Alcohols	Diethylene glycol	S
	Butyl Cellosolve®	S
	(Union Carbide)	
	Methyl Cellosolve®	-
	(Union Carbide)	-
	Methyl Carbitol® (Union Carbide)	-
Ketone Alcohol	Diacetone alcohol	S
Ethers	Dioxane alcohol	S
Ketones	Dioxane Tetrahydrofuran	S
Lactone	Butyrolactone	S
Amine	Triethanolamine	S
Esters	Ethyl acetate (95-98%)	S
	sec. Butyl acetate	S
	Methyl Cellosolve® acetate	S
	(Union Carbide)	
Chlorinated Hydrocarbons	Carbon tetrachloride	S
	Methyl chloride	S
	Tetrachloroethylene	S
	1,1,1-Trichloroethylene	
	Chlorothese® (Dow)	-
Aromatic Hydrocarbons	Benzene	S
	Toluene	S
	Xylene	S
Nitroparaffin	Nitroethane	S
Lactams	Methylpyrrolidone	S
	2-Pyrrolidone	S

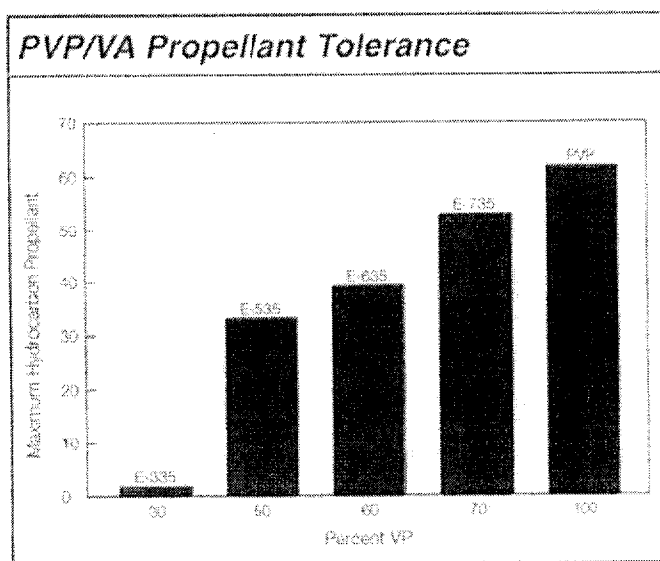
**Mixtures of 20 parts copolymer with 80 parts solvent (i.e. 10% solids content)

S=soluble

*No alcohol tax permit from the U.S. Treasury Department is necessary for the use of the I-series.

VA (vinyl acetate) is a more hydrophobic molecule than VP (vinylpyrrolidone). Thus increasing VA content of the copolymer causes an increase in hydrophobicity and consequently a decrease in water solubility and hygroscopicity relative to the VP homopolymer.

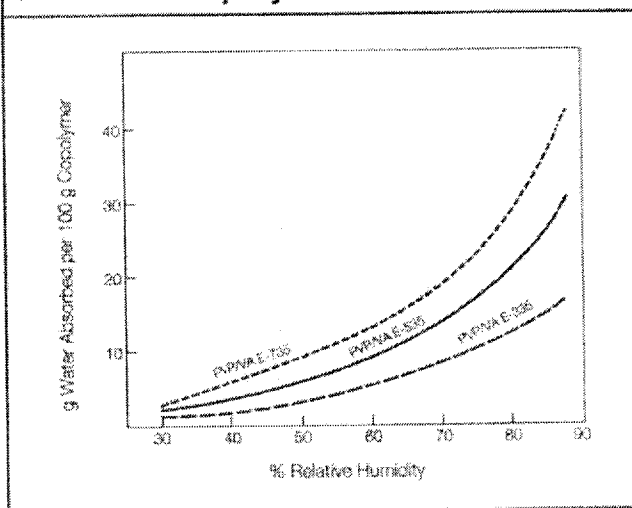
PROPELLANTS: PVP/VA copolymers are compatible with most of the common hydrocarbon propellants used in spray formulations. The propellant tolerance of PVP/VA E copolymers is reflected in the following bar graph:



PLASTICIZERS AND POLYMERS: Most PVP/VA copolymers are compatible with a variety of nonionic and cationic polymers. Compatibility with anionic copolymers can be achieved through neutralization prior to mixing.

HYGROSCOPICITY OF FILMS: The inherent water sensitivity of PVP/VA copolymer films varies with the monomer ratio. Typical data are shown below for PVP/VA E-735, PVP/VA E-535 and PVP/VA E-335. In general, PVP/VA is less hygroscopic than PVP.

Relative Hygroscopicity (at equilibrium) of PVP/VA Copolymer Films



AIR PERMEABILITY: PVP/VA copolymer films are permeable to air and oxygen, an advantage in many applications, e.g., spray bandages and protective coatings for plants.

PVP/VA APPLICATIONS AND MARKETS

PVP/VA copolymers are widely used for their excellent film forming properties in the following applications and markets:

- Coatings on paper, film, other substrates
- Water remoistenable adhesives
- Water soluble adhesives
- Decorative and protective coatings
- Photoresist/solder mask binders
- Shampoos, gels and hair sprays
- Hair tints and dyes
- Styling lotions and mousses
- Agricultural chemicals
- Bioadhesives
- Tablet coating
- Protective masks
- Plant leaf sprays

Industrial: In hot melt adhesives, PVP/VA copolymers are used in a variety of water remoistenable or water removable adhesives as listed below. Here they offer the formulators performance advantages in film flexibility, adhesiveness and water remoistenability.

Water Remoistenable Adhesives

PVP/VA Type

- | | |
|--|----------------|
| • Solvent based formulations | E and I Series |
| • Hot Melt | S-630 |
| • Hot Melt, pressure sensitive, repulpable | S-630 |

Water Soluble Adhesives

- | | |
|---------------------------------------|--------------------------|
| • Label adhesive for beverage bottles | S-630,
E and I Series |
|---------------------------------------|--------------------------|

PVP/VA copolymers are also used in coatings for ink-jet media including paper, plastic films and other substrates to enhance dye receptivity. PVP/VA S-630 is used as a binder to allow the aqueous processing of photoresists.

Personal Care: In personal care, PVP/VAs offer the formulators the added advantages of film flexibility, adhesiveness, luster and water rewettability.

Pharmaceutical: PVP/VA copolymers have found usage in the following pharmaceutical applications:

- Bioadhesives
- Tablet Coatings
- Controlled Release

Due to their rewettability characteristics, PVP/VA copolymers offer the bioadhesive manufacturer an excellent product.

In addition, their film forming and solubility characteristics afford the formulator the advantage of releasing the active agent in a controlled fashion.

TOXICITY DATA

Members of the PVP/VA copolymer family have been well studied in numerous acute, subchronic and chronic toxicity studies in animals, as well as in human skin clinical testing. Results indicate that these copolymers demonstrate a low order of acute oral toxicity and are neither primary dermal irritants nor sensitizing agents. Primary eye irritation studies on the copolymers in alcohol demonstrate minimal to severe irritation in the rabbit due to the alcohol. Chronic studies demonstrate no adverse effects following both oral administration in the mouse and rat and inhalation in the rabbit and hamster.

Based on these data, the Expert Panel of Cosmetic Ingredient Review has concluded that "Polyvinyl-pyrrolidone/Vinyl Acetate copolymer is safe as a cosmetic ingredient under present conditions of concentration and use."

STORAGE AND HANDLING

PVP/VA copolymers are stable for at least one year under normal conditions of storage but strict precautions should be taken to avoid moisture pickup. The E and I series have flash points in the range of 50-55°F (10-13°C) and are classified as flammable (DOT Flammable) materials. For safety reasons and to prevent moisture pickup due to drum breathing with changes of temperature, store in a dry place below 100°F (38°C) and repack or use in explosion-proof facilities.